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A FEW
CANADIAN CLIMATES

BY
J. GORDON MOUAT.

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Of the water influences which affect the climate of Canada, that of the Pacific Ocean is by far the most extended and far-reaching. The atmospheric drift of the middle latitudes bears it across the ranges of the Rocky Mountain system and diffuses its ameliorating warmth over the vast plains of the Saskatchewan and Athabasca. The influence of the Atlantic is limited to the few hundred miles over which the eastern surface winds from the sea are drawn inland towards the cyclonic areas advancing from the west. The St. Lawrence valley shows this influence in the winter temperature, which is higher than in the central parts of the continent on similar latitudes, and in a heavier precipitation. The unequal influence of the two oceans tends to throw the meridian of greatest summer heat and winter cold—which, were these influences equal, would lie in the central part of the continent—towards the eastern coast. But here nature has provided a check in the existence of Hudson's Bay and the Great Lakes, which temper the heat of summer and mitigate the winter's cold. It is not, therefore, in the meridian of the Great Lakes that the greatest extremes are found, but westward in the valleys of the Mississippi and Red Rivers.

The influence of the Great Lakes is very marked. In the lake region of the Province of Ontario the mean of the three coldest months varies from nearly 30° Fahr. to a little less than 15° . At similar latitudes in the Mississippi valley, and at almost similar elevation above the sea, the mean temperature of these months varies from 24° to 4° . The winter isothermal of 20° skirts the north shore of Lake Huron on the 46th parallel, descending in the Western States nearly to latitude 41° . The winter mean of 25° has in Ontario an average latitude of 43° , while in the Mississippi valley it

reaches as far south as North-Western Missouri in latitude 39° . When the occasional extremes of winter cold are considered, the influence of the Great Lakes is found to be even more marked than in regard to average temperature. The lowest temperature in the past twelve years in Toronto, (lat. $43^{\circ} 39'$) was only $-18^{\circ} 4$, Fahr. : Hamilton, (lat. $43^{\circ} 16'$) records $-20^{\circ} 5$, and Windsor, (lat. $42^{\circ} 19'$) $-19^{\circ} 5$,—while portions of the Niagara and Lake Huron districts show no temperatures lower than 12° below zero. Within shorter periods, not exceeding in any one instance eight years, the following temperatures were recorded at meteorological stations in the Mississippi and Missouri valleys :—

Cairo, Ill., lat. $37^{\circ} 0'$	-16°
St. Louis, Mo., lat. $38^{\circ} 37'$	-21.5
West Leavenworth, Kansas, $39^{\circ} 20'$	-29.0
Indianapolis, Ind., $39^{\circ} 47'$	-25.0
Lafayette, Ark	-17.0

To instance minimum temperatures in the past eight or nine years at stations further up the Mississippi valley is superfluous. Temperatures 40° below zero have been recorded at places in this valley no further north than the Canadian stations cited. During the present winter temperatures as low as -32° have been recorded in the State of Missouri. The lowest in Toronto has barely exceeded -13° . In the winter of 1874-5, the coldest on record in Ontario, when in Toronto the minimum temperature was -16° , temperatures as low as -39° were reported in Northern Illinois.

In short, the lake region of Ontario has as mild a winter mean as the Mississippi valley two hundred and fifty miles farther south, and eastward of the Rocky Mountains it is only to the south and east of a line drawn from Lake Erie to North-Western Texas that the thermometer does not occasionally fall as low as the lowest ever reached in the milder parts of the Province of Ontario.

It is interesting to notice in connection with the influence of the Great Lakes in modifying the cold of winter that the shore of Lake Michigan, opposite Chicago, has a mean winter temperature nearly four degrees higher than that of the city mentioned, and that while the pear grows with difficulty at Chicago, the much more tender peach grows luxuriantly far northward along the eastern side of

Lake Michigan, and over several thousand square miles in the Province of Ontario. The area over which the peach can be grown in this Province is nearly ten thousand square miles. It is even found to succeed on favorable soils and situations at Owen Sound, on the Georgian Bay.

If the winter cold of the Province of Ontario is mitigated by the Great Lakes, so also is the summer heat. The great central plains of the Mississippi and Missouri in summer become so heated that the mean temperature of July in Missouri and Kansas is little less than that of New Orleans in the same month. The influence of the solar rays on these great interior plains is so great that the trade winds of the Atlantic, drawn eastward into the Gulf of Mexico, are deflected northward and, affected by the prevailing eastward drift of the atmosphere, are finally carried, charged with moisture, north-eastward occasionally to the Ohio valley and the borders of the Great Lake region. Far northward, in summer, torrid influences prevail. Temperatures of 110° and upward are experienced in Dakota and Montana, and even further north across the international boundary of 49° in the Canadian valleys of the tributaries of the Missouri. But the Great Lakes interpose a buffer against the easterly drift of the interior heat. The isothermals which in winter trend southward after leaving the lake region, in summer trend north-westerly beyond Lake Michigan. The July isothermal of 74° , which is found in Ontario only in the very warmest localities of the Province, reaches a parallel two hundred miles further north in the great plains of the west. The mean temperature of 70° for the three midsummer months, which in Ontario is found rarely northward of the 43rd parallel, is reached very nearly as far north as the 49th parallel in the North-Western States and Territories. It is not until October that latitude for latitude and altitude for altitude the mean temperatures of Ontario and the Mississippi valley are equalized. The decline in temperature thenceforward till winter has set in is more rapid in the Mississippi valley than in the region of the Great Lakes which, warmed by the summer's heat, delay the advent of winter several weeks after that season is established in the central parts of the continent. The advent of spring in the lake region is also later than in the west, partly owing to the retarding effects of the lake water, which has been chilled by the winter's cold,

and partly to the greater distance from the now rapidly heating plains of the Lower Mississippi. The effect of this delay of spring is not disadvantageous, for the occurrence of the last frost damaging to vegetation is very nearly alike in point of time in the lake region and in the central parts of the continent, and in the former districts, vegetation being less advanced when that frost occurs, suffers less from its effects. The general effect of the greater liability of the Mississippi valley to intense frosts in winter, sudden changes and late frosts, is such that north of Tennessee no peach districts are found which compare, in immunity from injury through low temperatures, with the peach belts east of Lake Michigan and in the neighborhood of Lakes Erie, Ontario and Huron.

What is true of the annual and seasonal extremes of the lake region and the Western States, has its parallel in regard to the daily range of temperature. It is only once in many years that Toronto, which is fairly representative in this respect of the lake borders of Ontario, knows a range of forty degrees in any one day. The late Prof. Loomis, discussing the results of two years' records of over one hundred stations scattered over the continent north of the 35th parallel and between the Rocky Mountains and the neighborhood of the Atlantic, states that only in the Province of Ontario had he found stations at which the mercury had not ranged occasionally forty degrees in a single day. At the stations in the Mississippi valley and westward to the Rockies, greater changes than forty degrees were recorded several times in each of the two years; at several stations twenty to sixty times. Even as far south as Northern Texas sudden changes of remarkable extent are recorded by the American Signal Service. In one instance a fall from 80° to 18° within a few hours is noted; and on the 7th of September, 1881, on the northern borders of Texas, a sudden lowering of temperature proved fatal to over 300 cattle. The facts given show that in equability of climate the Province of Ontario is one of the most favoured districts in the temperate latitudes of this continent.

While the whole of the lake region of the Province of Ontario as far east as the Ottawa River experiences the modifying influence of the great lakes, the measure of that influence differs greatly according to elevation, and distance and direction from large bodies of lake water. In fact, the lake influence, while rendering the whole region more temperate than any part of the Mississippi Valley to the west-

ward, increases the differences beyond those due to latitude, so that the part of the province south of the 46th parallel presents a much greater variety of climate than any other non-mountainous district of equal area on the continent. Eastward from the Georgian Bay the effect of the great lakes in moderating heat and cold rapidly decreases, and continental conditions rather than semi-insular gradually come to prevail. Lake Ontario not lying in the direction from which the areas of low and high barometer advance on this region, has but a very limited influence. There being no large body of water to the north, such winter anti-cyclones as take a course to the Atlantic to the northward of the great lakes pour their refrigerating northern blasts down over this region.

At Ottawa the summers are hotter than at Toronto, Goderich and many other places a hundred miles or more further to the south, and though the summers over the Ottawa district are shorter than in much of the south-western part of the Province, the mean temperature of July is quite as hot as in most localities in the latter and the maximum temperature very frequently is higher than 95° in the shade; it occasionally exceeds 100° and usually is several degrees hotter than at Toronto, the eastern shore of Lake Huron, and even localities as far south as Lake Erie. The winters of Ottawa on the other hand average as low as 13° Fahr., and are much the same as at Moscow. The average minimum is about 30° below zero. Snow falls deep and the sleighing season is usually four months in length while in parts of south-western and southern Ontario, it is not as many weeks. Though the difference in latitude between Ottawa and Niagara is only about two degrees, the winters of the former place are at least as much colder than those of the latter as the winters of Niagara are colder than those of Memphis in Tennessee, eight degrees still farther south. Yet the sensible cold is not so great as this large excess might suggest; it is usually enjoyable, the atmosphere being dryer and there being more sunshine than in districts more within the influence of the lakes.

The district of Muskoka & Parry Sound, bordering on the Georgian Bay, experiences in greater measure the influence of the Georgian Bay and Lakes Huron and Superior in tempering the heat in summer and the cold in winter of winds from the western semi-circle. This influence is necessarily much more marked in winter; though the elevation of much of the district makes the apparent amelioration

less preceptible than it otherwise would be. The summers of Muskoka are cooler than those of any other part of Ontario south of the 47th parallel of latitude. But this tempering of the heat is due in large measure not so much to the influence of the Georgian Bay as to general elevation and the number of small lakes of great depth and coolness. Like the Ottawa Valley, though not to the same degree, the district is open to cold northerly winds in winter blowing outward from such centres of high pressure as move eastward to the Atlantic in high latitudes. Elevation adds to the cold of these north winds, which however are infrequent in some winters. At Huntsville (about lat. $45^{\circ} 15'$) in Eastern Muskoka, the temperature in Jaquary 1882 during the passage of almost the only severely cold anti-cyclone of the season, fell under a north wind to a temperature 30° lower than was reached at Toronto, and actually 47° lower than at Windsor, less than three degrees further south and little more than 280 miles distant in a direct line. In severe winters, a large part of the Georgian Bay, encumbered with islands, freezes over and the tempering effect of the lake water is thus greatly diminished.

The winters of the large island of Manitoulin, which approaches the 46th parallel, are milder than those of Muskoka. Of the climate of the north shore of Lake Huron beyond the 46th parallel, the meteorological records are meagre. The district is protected against cold west winds in winter by Lake Superior, but is open to cold blasts from the north-west, north, and north-east. The winter isotherm of 20° skirts the coast; inland the winters are colder. The summers are said to be warmer than those of Muskoka, notwithstanding the higher latitude. Small lakes are less numerous, and are shallow and heat rapidly. Neighbourhood to the great breadth of land between Lake Huron and James' Bay—an area which sometimes becomes intensely heated in summer has probably also some effect on the summers of the district. The heat of the southerly winds is of course greatly tempered by the great length of Lake Huron stretching against them.

At a distance of from 12 to 20 miles north of the north shore of Lake Ontario extends from the Highlands of Grey in peninsular Ontario to the head of the Bay of Quinte, a ridge or watershed attaining at a few places an elevation of nearly one thousand feet above the sea, and doubtless having some effect on the climate of the basin of Lake Ontario. Eastward from the easterly termination of

this ridge the land slopes back from the lake far inland to the central heights of the watershed between the Georgian Bay and the Ottawa River. The lake has an elevation of only 234 feet (264 according to American surveys between the Atlantic and Oswego) above the sea. This comparatively low level conduces to raise the temperature of the borders of the lake. The comparatively moderate temperature of winter induced by lake influence and low level, the presence of high land to the north and west, and distance from lake water to the west, render the snowfall of the district lighter than in any other part of the lake region, with the exception of the district immediately north of Lake Erie. Sweeping over these high lands the north-west and westerly winds of winter which in passing over Lake Huron absorb considerable moisture, precipitate most of that moisture, and on regaining the low level of the Ontario basin resume almost their normal dryness. Owing to the comparative narrowness of the lake, and the fact that the winds which blow across it are not common or prevalent winds, the north shore, especially in its westerly portion derives a comparatively small proportion of its rain and snowfall from the lake, and the average annual precipitation is less than in any other part of the lake region with the exception of a limited district immediately north of Lake Erie. Towards the east end of the lake the same influences which make the climate of Ottawa extreme begin more and more to prevail; and the duration of sleighing gradually increases, till at Kingston it is nearly three months in length.

The climate of Toronto fairly represents in kind the characteristics of the north shore. At a low level and protected by the lake against the warm southerly winds, and by Lake Huron and the Georgian Bay from the cold northerly and westerly winds of winter its seasonal and daily range is comparatively small. The summer is cooler than in almost any of the larger towns in Ontario; and few have winters as mild. The mean temperature of January—about 23° for the eight years, 1874-'81, is nearly nine degrees higher than in Montreal, and is higher than in the uplands to the south-west, or than near Chicago, a degree and three-quarters farther south. The average minimum of January is $-3^{\circ}.1$, the average minimum of the year $-11^{\circ}.0$; the absolutely lowest in the eight years cited, $-16^{\circ}.0$; and in the past twenty-five years $-18^{\circ}.4$. The latter temperature is not so low as has been recorded within the same period at Louisville, Kentucky, or St. Louis, Missouri. The average duration of sleighing appears

to be between three and four weeks ; in some winters there has been no sleighing whatever. An examination which I have made of the records of Toronto observatory for the past thirty Christmas days shows that only on four of these holidays, or little more than one in eight, has there been sufficient snow to permit the running of sledges, and on thirteen occasions the ground was bare. The interposition of the lake water against hot winds from southerly points of the compass greatly tends to prevent extremes of heat. The summer of Toronto is cooler than that of Montreal, the Ottawa Valley, and parts of the interior to the north, north-east and west of the city, and as cool as the eastern shore of Lake Huron. The mean temperature of July for the eight year period cited is $69^{\circ}.01$ —which is little more than three degrees warmer than Paris, France, over five degrees farther north ; and is less than two degrees for the same period warmer than Winnipeg, where though the latitude is higher by $6\frac{1}{4}$ degrees, full continental influences prevail. The freedom from warm extremes both winter and summer is more noticeable. The average maximum of January is only $46^{\circ}.25$. The absolute maximum (Dec. 31, 1875) of mid-winter in eight years was only 61° , while that of Galt, 56 miles westward and 520 feet higher, was 66° ; that of Hamilton, 42 miles distant, but at the west end of the lake, 71° , and that of the Niagara district, 40 miles distant, nearly 80° in the shade. The average maximum of the year is only $91^{\circ}.5$; that of Hamilton is $96^{\circ}.9$, while over the Lake Erie district and over most of the inland parts of the Province as far as the Upper Ottawa, the average maximum is in most localities as high as 95° . The absolute maximum in twenty years past is only $95^{\circ}.4$. At Ottawa and even in Muskoka it has exceeded 100° , while at Hamilton it has reached $106^{\circ}.3$ in the shade. It is interesting to note in passing, that moderate as is the annual maximum at Toronto as compared with other localities in the Province, it is a little higher than at Charleston, South Carolina.

At Toronto, as, more or less, along the shores of the Great Lakes, a lake breeze by day and a land breeze by night, blow during hot, calm weather. These breezes usually do not affect the climate for more than a few miles from the shore. Inland, notwithstanding the increased elevation, the temperature is higher in the day time during the summer months than it is at Toronto.

Hamilton, only forty-two miles distant from Toronto, and only twenty-three minutes further south, has a much warmer climate, and

illustrates in an interesting manner several of the peculiar differences due to situation. Like Toronto it is exposed to the northerly winds modified by the Georgian Bay a hundred miles to the northward, but it is in a measure protected from the north-easterly winds by the intervention of Lake Ontario. More important in its bearing on the climate is the fact that the southerly and south-westerly winds which in reaching Toronto, have part of their warmth abstracted by Lake Ontario, reach Hamilton after blowing over a considerable stretch of land. Hence the latter place attains much higher temperatures in all seasons of the year than are reached on the north shore: the mean temperature is also higher. In addition to these causes which tend to increase the daily and seasonal range, the situation of the city on a low plain with a steep escarpment on the south and a range of hills across the bay on the north, tends to the existence of great daily contrasts, for in certain conditions of weather, the heat appears to accumulate in the sheltered "ravine" while in other conditions the heavy cold night air of the upland pours over the "mountain" and displacing the warm air, settles beneath it.

A remarkable instance of the effects of situation in a ravine, cutting through an extended upland, is afforded by the records of Galt on the Grand River. In 1879 the writer had charge of the meteorological station in the valley of that town. On the edge of the plateau to the west, a little more than a mile distant from the ravine station and about 180 feet higher than the latter, was a second station in charge of a careful observer, Mr. Alex. Barrie. The thermometers at both stations were protected by the fence and screens approved by the meteorological service and in use at Toronto Observatory, and great care had been exercised to make the conditions of exposure similar. Here while the average daily maximum temperature was about two degrees higher at the valley station than on the plateau, the relative temperatures were sometimes greatly reversed. On Oct. 10th 1879, the maximum at the plateau station was $90^{\circ}.3$, while at the valley station it was but $79^{\circ}.3$, eleven degrees lower. On another date in the same year the difference was still greater, the thermometer at the 9 p.m. reading on the plateau being 79° , when in the valley it was only 65° , or fourteen degrees lower. There being no station at Hamilton, other than in the valley, similar instances there of the inflow of cold air cannot be cited. But the effect of this occasional inflow is seen in the facts that while the mean temperature and

monthly maxima at Hamilton are higher than at Toronto, the monthly minima, from July to October, are very nearly the same at both places. The following tables show the average monthly maxima and minima at Hamilton and Toronto over a period of eight years (1874-81):—

AVERAGE MONTHLY MAXIMA.

	JAN.	FEB.	MAR.	APR.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.
Hamilton.	49·7	50·9	58·2	72·0	89·0	91·0	93·0	94·0	90·3	81·6	64·3	54·9
Toronto ..	46·2	44·5	50·8	66·0	83·8	86·2	89·6	87·4	84·3	71·3	57·4	48·7

AVERAGE MONTHLY MINIMA.

	JAN.	FEB.	MAR.	APR.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.
Hamilton.	—0·1	—1·6	6·3	18·9	31·1	42·2	49·9	47·4	37·5	26·9	11·2	2·5
Toronto ..	—3·1	—3·3	4·0	16·6	29·0	40·4	49·2	47·8	37·6	26·3	7·5	—1·7

The average yearly maximum at Hamilton is $96^{\circ}\cdot 9$, the average yearly minimum $-7^{\circ}\cdot 4$; the lowest temperature recorded in the eight years (1874-81) from which these averages are obtained was $-20^{\circ}\cdot 5$; the highest $100^{\circ}\cdot 5$. The absolutely highest temperature on record was $106^{\circ}\cdot 3$ (July, 1868), a degree of heat which has not been reached at New Orleans, or at Naples or Calcutta, in a period of at least 18 years. The average annual maximum is quite as high as at New Orleans or cities to the eastward along the Gulf of Mexico.

The mean temperature of the different months at Toronto and Hamilton for the eight-year period mentioned is as follows:—

	JAN.	FEB.	MAR.	APR.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.
Toronto ..	22·7	22·2	28·7	40·2	54·2	62·6	69·0	67·8	60·3	47·6	35·1	26·4
Hamilton.	24·4	24·6	31·1	42·5	57·7	66·0	73·3	71·4	63·9	50·3	37·1	28·4

The mean of the year at Toronto is $44^{\circ}\cdot 74$, and at Hamilton $47^{\circ}\cdot 47$ or $2^{\circ}\cdot 73$ higher. The daily range in Toronto is about 13° in January, and nearly 20° in July, while at Hamilton the figures for these months are respectively about 20° and 27° . The average daily maximum of July, at Hamilton, is above 84° in the shade, and not 79° in Toronto. In the warmest month ever recorded in Hamilton (July,

1868), the mean temperature was 80° with an average daily maximum of 93° in the shade. In Toronto the mean of the same month was $75^{\circ}.8$, with a mean daily maximum of only $85^{\circ}.4$. These contrasts sufficiently illustrate the effect of the different situation of the two cities in regard to the water of Lake Ontario.

Along the south shore of Lake Ontario, eastward to Niagara, the general features of the climate of the belt of land referred to, resemble those of Hamilton, though the thermometer does not fall so low at night as in that city. The summer heats are intense, and temperatures above 70° have even been recorded in mid-winter. The season is, over much of the district, longer than at Hamilton, where the average period between the last fall of the temperature in spring to 32° , and the first descent in autumn to the freezing point, was for three years (1878-80), 186 days. The measure of protection afforded by Lake Ontario from the winds from northerly points of the compass increases, and the mean temperature of winter rises. Lake Erie also affords a measure of protection against the cold which in winters unusually severe in the Western States sometimes accompanies south-westerly winds. At Niagara the mean of winter is several degrees higher than at Hamilton, and nearly as high as at New York, and the average minimum of the year is little, if at all, below zero. The heat and duration of summer and the comparative mildness of winter make the district peculiarly well adapted to fruit growing. The peach-orchard area of the district is very large, and vineyards averaging four to five tons of grapes to the acre are numerous. The sweet potato and the peanut flourish in a degree unsurpassed in any other district in the province. The mulberry grows luxuriantly. The pseudo-papaw, and the tulip tree, *Liriodendron tulipifera*, grow wild in the woods and attain large proportions. At Niagara the writer has found fig-trees heavily laden with fruit, growing in the open air with but little winter protection; and the soft-shelled almond, though of course but little cultivated, with slight winter protection, produces fruit equal to that of the common almond of commerce.

The north shore of Lake Erie, like the north shore of Lake Ontario, and for similar reasons, is marked by a tendency to the avoidance of great extremes of heat, though owing to latitude and the shallowness, and therefore greater warmth, of the water, the hot extremes of the summer months, and the mean temperature are higher than on the

north shore of Ontario. In exceptionally severe winters, ice forms to a greater extent on the bays and indentations of Lake Erie than along the Lake Ontario coast, and though the mean temperature on the north shore of Erie is higher than on the same shore of Ontario, the winter maximum in such seasons is no greater than at Toronto. The snow of winter is light, and usually lies but a short time, even in winters when around Buffalo the depth is great and the sleighing of long duration.

The eastern shore of Lake Huron has a climate differing in several important particulars from the Canadian shores of Lakes Erie and Ontario, and illustrating more than these lakes the peculiar effect of a large body of water interposed against the prevailing westerly winds. The winters are nearly two degrees warmer than at Toronto, and are as mild as those of Hamilton, as free from cold extremes as at Niagara, and from warm extremes as at Toronto, yet the moisture of the lake winds makes the sensible cold appear greater than in the interior or in the Niagara District. Spring is retarded by the lake influence, and the mean of that season at Goderich is no higher than at Toronto; but on the other hand the autumn is several degrees warmer: summer is as cool as at Toronto, and comparatively free from very high temperatures. Goderich, lat. $43^{\circ} 25'$; altitude, 728 feet, has a mean temperature for the year a little higher than Toronto. Zero temperatures, and temperatures above 90° are rare; and the contrast in this respect with the Michigan shore opposite, is very marked. The climate is one of the most equable of the whole lake region, and surpasses in this respect almost every other district in the middle latitudes of the continent. The peach grows far north, and even on the Georgian Bay. Towards the southern part of the district, peach-growing is an important industry. Owing to the moisture of the lake winds, this shore is not so well adapted to the vine as the ordinary or low levels of peninsular Ontario. The rainfall and snowfall are both heavy, for to the rainfall brought by cyclonic areas, there is added the moisture gathered by westerly winds from the lake. The north-westerly winds, normally intensely dry, gather a large amount of moisture from the lake, and in winter when the land is chilled, this moisture is precipitated in snow flurries to a considerable depth. The interior of peninsular Ontario varies greatly in elevation, rising slowly and gradually from Lake Erie; more rapidly from Lake Huron and still more abruptly from the Georgian Bay, up to the

Highlands of Grey, where an elevation of 1,700 feet above the sea is attained. Consequently, considerable differences in climate exist in this interior. On the Highlands of Grey, and on the Lake Huron slope the snowfall is often excessively heavy, and the snow lies several feet in depth, when in some districts of the Province the ground is bare. Sleighing usually lasts for three months or more on the highest levels. Of the annual precipitation of this part of the interior, there are but few records, and these cover but a very short period. There is reason, however, to think that the annual precipitation in some localities, as in Muskoka, exceeds 50 inches, that is, amounts to nearly twice the precipitation of the driest localities of the Province. The explanation of this heavy precipitation has already been sufficiently indicated.

The winter temperature of the central watershed, owing to great elevation, is cold, averaging in some localities below 20° . The extremes of cold, too, are great, though on these, as on the winter mean, the surrounding lakes exercise a moderating influence, and the temperature usually does not fall so low as at Ottawa or as in the Western States at even lower levels and much lower latitudes.

The difference in mean summer temperature between the lake shore and the highest land of the interior, is not great when the difference in altitude is considered. The mean of July, at the highest points, is about 65° and the maximum heat is about as high as on the Lake Huron shore. The degree of heat attained is due, in a large measure, to the extent of unbroken land to the south and southwest. At Owen Sound on the south shore of the Georgian Bay, so much does this large land area in the direction of the warm winds affect the climate, temperatures as high as 95° have been reported in the month of May. At elevations of 1,000 to 1,200 feet, the mean of summer is nearly as high as at Toronto, and the daily and yearly maxima are higher. The difference from the lake coasts and lower levels is chiefly in the existence of a greater daily and seasonal range on the high land and a shorter period of exemption from early and late frosts. On the long slope towards Lakes Erie and St. Clair, the mean temperature of all seasons gradually rises, and at some distance inland the mean temperature of summer exceeds that of the Erie coast by several degrees, and almost equals that of the very warmest localities of the Province. In extremes of warmth, both summer and winter, the temperatures are higher than in most localities near the

lakes. At Galt, lat. $43^{\circ} 20'$, altitude 870 feet, the mercury usually rises to 95° , and has exceeded 100° . London sometimes records a higher July mean than even Hamilton or Windsor. At Zurich, towards Lake Huron, 103° was reported in 1881. Perhaps as forcible an illustration of the tendency of the interior to develop extreme heat as can be given, is in the fact that while in 1881, at Brantford, lat. $43^{\circ} 10'$, altitude 720 feet, there were in May 7 days, in July 21 days, in August 16 days, and in September 7 days—51 in all—on which the mercury rose above 90° in the shade, and while the highest temperature was 99° , in Toronto there were but five days, in all, on which a temperature above 90° was reached, and the very highest was only $92^{\circ}.7$. Towards the south-western portion of this inland district, the absence of lake water to the south-west, between the foot of Lake Huron and the head of Lake Erie, fully admits the south-west wind, which is usually warm, and winter temperatures comparatively high are often recorded. An indication of the general climate of this Lake Erie slope is that the peach is grown, on suitable soils, to an elevation of about 1,000 feet above the sea.

In much of the interior of peninsular Ontario, thunder storms are numerous and more severe than on the north shore of Lake Ontario. Tornadoes also occur more frequently, though they are not so violent nor so frequent as in equal areas in Ohio, Indiana and the Central Western States. The snowfall of the Lake Erie slope rapidly diminishes as the distance from Lake Huron increases. North-west winds which near Lake Huron and in the highlands of Grey, bring several inches of snow in a single day are usually snowless over the southern half of the peninsula. At Galt the average duration of sleighing is not more than six weeks; southward and south-westward the period decreases to a few days. The advent of spring is one or two weeks earlier over much of the southern part of the district, than at Toronto, and winter-wheat harvest is almost as much earlier. Harvest usually commences in the beginning of July and has been known to begin in the end of June, as far northeast as Galt, and about the 15th of June a short distance north of Lake Erie.

The climate of Windsor on the Detroit River, lat. $42^{\circ} 19'$, altitude 604 feet, is fairly representative of the climate of the extreme south western part of Ontario. Immediately to the north is Lake St. Clair, and not far beyond that lake, Lake Huron, affording protection from the cold north winds of anti-cyclones passing eastward north

of the great lakes. To the south at no great distance is Lake Erie affording only a slight protection against the warmth of the south wind in winter. But against the cold in winter of westerly and north-westerly winds there is no shelter except such as the distant Lakes Michigan and Superior supply, and against the warmth generally, and in some winters the excessive cold, of the south-west wind there is little or no protection. Lake St. Clair is shallow, and in severe winters freezes over, and loses its protective influence, and both it and the very shallow westerly end of Lake Erie become in summer greatly heated, and not only lose the protective influence against extreme heat which lake-water generally exercises, but even at times, and especially in autumn, increase the heat. The extreme south-west has therefore a climate, on the average of the year warmer than almost any other part of the Province, but more variable also than most of peninsular Ontario.

The winter mean is the same as that of Hamilton, but with monthly extremes of heat and cold greater than in that city. The average yearly minimum is about the same as at Toronto. Owing to the great differences in the temperature of different winters in the Western and South-Western States, and the consequently great differences in the temperature of south-westerly winds in different winters, the temperature of the Windsor winters differs very much. In eight years (1874-81) the coldest January was $14^{\circ}.7$ which is lower than any January in the same period at Hamilton or Toronto, or eighty miles northward at Goderich. The warmest January on the other hand was $36^{\circ}.2$, or considerably higher than any at Toronto or Hamilton. December means varied from $18^{\circ}.7$ to $38^{\circ}.9$; March from $26^{\circ}.6$ to $41^{\circ}.7$; April from $37^{\circ}.9$ to $54^{\circ}.2$. Though the midsummer months show little difference in their mean temperature in different years, October means ranged from $46^{\circ}.6$ to $58^{\circ}.9$; May from $57^{\circ}.2$ to $65^{\circ}.5$, and September from $59^{\circ}.0$ to $72^{\circ}.2$; the last higher than any Toronto July in the same period.

The mean of the summer months is almost the same at Windsor as at Hamilton. In autumn, with the exception of the month of October, the two places are alike in mean temperature. It is the temperature of the spring and early summer that makes the mean of the year at Windsor ($48^{\circ}.49$) one degree warmer than the annual mean at Hamilton. April at Hamilton has a mean of $42^{\circ}.5$; at Windsor $45^{\circ}.25$; in May the figures are respectively $57^{\circ}.7$ and $60^{\circ}.8$; in

June Hamilton averages $66^{\circ}.0$ and Windsor $67^{\circ}.85$. The earlier springs of Windsor are due in part to latitude, in part to greater nearness to the rapidly advancing heat of the south-west, and in part to the fact that easterly winds which prevail in spring reach Hamilton from the deep, winter-chilled lake, and Windsor from the warmer land of Essex and Kent.

The following table shows the mean temperature of each month, the average monthly maxima and average monthly minima at Windsor, for the eight year period (1874-81.)

	JAN.	FEB.	MAR.	APR.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.
Mean	24.1	24.7	32.4	45.3	60.8	67.8	73.4	71.4	63.8	51.6	37.1	28.4
Mean max.	50.0	53.5	61.8	77.3	88.9	91.7	95.1	93.5	90.5	81.2	64.5	53.3
Mean min.	-3.0	-0.6	9.4	18.8	30.0	47.3	51.4	48.3	36.8	25.0	10.4	0.0

The mean of the year is $48^{\circ}.49$; the mean maximum $96^{\circ}.25$, (very nearly the same as at Hamilton) and the mean minimum, $-10^{\circ}.75$ or $3^{\circ}.4$ lower than at Hamilton, and almost the same as at Toronto $2\frac{1}{4}$ degrees farther north. The absolutely highest temperature in the eight years referred to was $100^{\circ}.6$ (Sep., 1881): the absolutely lowest $-19^{\circ}.5$.

In the four coldest months the maxima were as follows:—Dec. $68^{\circ}.3$; Jan., $66^{\circ}.9$; Feb. $63^{\circ}.4$; March, $77^{\circ}.4$. The contrast with Toronto goes to show the effect of Lake Ontario in protecting against unseasonable temperatures. There the absolute maxima for those months were Dec., $61^{\circ}.1$; Jan., $57^{\circ}.5$; Feb., $51^{\circ}.6$; March, $58^{\circ}.4$. Absence of lake-water to the west renders the precipitation small compared with the adjoining Huron district. The snowfall is light, and the general temperature of winter, and particularly the warm extremes, reduces the average period of sleighing to a few days. The fruits and flora generally are the same as in the Niagara district. The vineyards are very productive, averaging in good soils five tons of grapes, and nearly 700 gallons of wine (first drawing) to the acre—a yield probably unsurpassed either in California or in Europe.

The southernmost part of Ontario and of Canada, Pelee Island, a township of 17 square miles (lat. $41^{\circ} 40'$ to $41^{\circ} 50'$ —further south than Rome), has a climate peculiarly interesting. The island lies

almost midway between Sandusky, Ohio, 20 miles distant, and Leamington, Ont., and with Kelly's, an Ohioan island, six miles to the southward, and the peninsula of Point Pelee to the northward, marks the dividing line between the very shallow and island-dotted western extremity of Lake Erie, and the larger, deeper and unbroken area of the lake to the eastward. This peculiar position produces remarkable climatic effects. The water to the westward is generally not more than forty feet in depth, and under the hot summer sun becomes so heated that temperatures above 80° are sometimes registered at lake bottom in the harbours along the neighbouring coasts. This high temperature not only tends to increase the average heat and length of summer, which here is almost as warm as at Cincinnati, but increases the warmth and length of autumn—which also is as warm and free from frosts as on the Ohio River—and reduces the difference between day and night temperatures to almost tropical smallness. Another effect, a physician on the island informs the writer, is that what corresponds with the nightly land breeze of the lake coasts in hot, calm weather, here blows not from the land, but from the deeper and cooler lake water to the eastward, into the heated western end of the lake. The effects in winter of the surrounding shallow water, vary with the severity of the seasons. In the milder winters the usual effects of water surroundings are experienced in a small daily and seasonal range. In severe winters the shallow archipelago of the western end of Lake Erie is encumbered with ice and sometimes freezes over, and Pelee partakes in greater measure of the continental character of the winter of the neighbouring mainland.

An examination of the records of the meteorological station on the island for a period of three and a half years bears out the deductions which otherwise could be made from the peculiar situation of Pelee.* The figures are interesting. The mean temperature, and mean monthly maxima and minima are as follows :

* The records, which through the courtesy of the Superintendent of the Meteorological Service, were furnished the writer, embrace the period between February 1st, 1879, and August 31st, 1882. The records for May, October and November, 1879, and April and November, 1880, are incomplete or wholly wanting. The mean temperature for these missing months has been approximated by the writer after careful examination of the records of Windsor and Sandusky, what is believed to be due allowance having been made for the peculiarities of the Pelee climate. The hours of observation were 7 a.m. and 12 and 9 p.m. The mean temperature is found by adding together the readings at the first two hours, adding the 9 p.m. reading, and dividing the sum by 4. The maximum and minimum temperatures given are those of the

	JAN.	FEB.	MAR.	APR.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.
Mean	26.2	27.4	32.5	41.7	59.2	67.1	73.5	72.9	66.3	56.4	38.7	29.1
Mean max.	47.7	54.3	54.5	65.0	85.3	91.0	95.0	91.5	90.7	72.0	62.0	49.7
Mean min.	6.7	7.0	18.7	18.7	40.3	51.3	61.5	59.7	49.5	37.5	28.0	9.0

The mean temperature of the year is $49^{\circ}25'$: did the record extend over the eight years which have been used for the averages of Toronto, Hamilton and Windsor, it would probably appear a small fraction of a degree lower.

The coldest January averaged $16^{\circ}5'$, or $0^{\circ}7'$ higher than the same month at Windsor, while the warmest, ($34^{\circ}8'$) was $1^{\circ}4'$ colder. The absolutely lowest temperature (-12°) occurred when the west end of the lake was covered with ice and was $5^{\circ}4'$ lower than at Windsor. The occurrence of lower temperatures than at Windsor during the same severe season suggests that the effect of a neighboring area of ice in extremely cold weather, is more favourable to the development of cold than is the vicinity of an unbroken land area, an explanation which may find additional illustration along the eastern side of the Georgian Bay. In mild winters the low extremes are higher at Pelee than at Windsor. In January 1880 the minimum at that town was 19° , while at Pelee it was only 25° . In the other months of the same winter the difference in favour of Pelee was from $4^{\circ}5'$ to $10^{\circ}5'$. The absolutely highest temperatures in the winter months were: Dec. 57° , Jan. 55° , Feb. 63° , March 60° . The extraordinary smallness of the mean daily range in winter is shown by a comparison between the averages of the 7 a.m. and the 2 p.m. readings. The average difference in Dec. is only $2^{\circ}2'$, in Jan. $3^{\circ}3'$, Feb. $6^{\circ}4'$, and March $5^{\circ}4'$. In December 1881 the average temperature was $34^{\circ}7'$, but the 2 p.m. reading was only $36^{\circ}1'$, and the 7 a.m. $34^{\circ}5'$, a total range of only $1^{\circ}6'$, between hours which represent, at this season

hours of observation only, but a careful consideration of the facts as to cloudiness, direction of wind, &c., at the times of their occurrence, and for some time before and after, leads to the conclusion that in many instances they represent within a fraction of a degree the true max. or min., as the case may be, and that in few instances can the highest or lowest temperatures have differed more than one or two degrees from these quantities as taken from hours of observation alone. Where the mean temperature of the month is not derived from the original records no attempt has been made at supplying maximum and minimum, or averages other than for mean temperature. The mean maximum and mean minimum of November is consequently derived from but one month, that of October from only two, those of January, February, April and May from three, and the remaining months of the year from four.

especially, very nearly the extremes of the day. The average daily range in January furnishes an interesting contrast with the range in the same month at Toronto and Hamilton.

April at Pelee is almost as cold as at Toronto, and is more than 3° colder than at Windsor, thirty miles further north. The effect of the cold lake water is shown in the fact that the highest maximum in this month was 82.9° , (April 1881) while in Pelee it was but 68° . Yet the last frost of the season is several weeks later at Windsor than in Pelee, where it occurs about the middle of April. In May, Pelee almost regains the normal temperature of the districts on the neighboring mainland : temperatures above 90° are recorded and frosts are known only in exceptional years.

The summers are hot and steady. In only one June in four years was a lower reading than 50° recorded. In July and August only once in the same period was there a lower reading than 60° . The daily range in summer is much greater than in winter but still not half so great as at most stations on the mainland of Ontario. The range between 7 a.m. and 2 p.m. for June is $8^{\circ}.4$, July $8^{\circ}.6$, Aug. $7^{\circ}.5$. The daily range above the mean temperature is in summer twice as high, as the range below the mean, the nights maintaining an almost even temperature of about 70° in July and August, while the day temperature rises in July to at least 80° . This daily maximum is not so high as that of some parts of the Ottawa Valley, and is much below the daily maximum of Hamilton and Windsor, where however the night temperatures fall considerably lower than at Pelee.

Intensely tropical weather frequently prevails for days together, when, though the mercury does not rise any higher than on the mainland, it does not fall at night below 80° . In the steaming atmosphere of this shallow lake such days must be very oppressive. The following are instances from the records :

	7 a.m.		2 p.m.		9 p.m.
July.....	86°		96°		83°
Aug.....	83°		95°		85°
Sept.....	82°		98°		84°

September, in regard to heat, is properly a summer month, its mean being higher than that of a Paris July, and little lower than that of a Toronto August. In 1881 the mean was 72.9° , with a minimum temperature of only 58° .

October averages $56^{\circ}.4$, nearly ten degrees warmer than at Toronto, and quite as warm as in the Ohio Valley. November prolongs the balmy, hazy weather which persists here for months, and it is not till about the 12th of the month that the first hoar frost of the season usually occurs on the warmer soils of the island.

In winter sleighing is rare. The rainfall in the warmer months is comparatively light, owing to the high temperature above the shallow surrounding waters checking condensation.

The mean period in which the mercury does not fall to 36° —the average point at which hoar frost here occurs—is nearly seven months in length, or quite as long as at Memphis, Tennessee, and much longer than throughout most of Ohio and Indiana. It extends from April 14th to Nov. 12th. The great length of the season, combined with the long steady heat admits of the full maturing of cotton, which at one Pelee farm visited by the writer, has been grown for many years without any special care either to secure protection or early maturity. Climatic conditions are more favorable to the cultivation of the Catawba grape on Pelee and adjacent islands than in any other part of America. Including the mainland on both sides of the lake, this district is the most famous wine district on the continent, with the exception of a small area in California, where however the yield per acre is not greater than here. On the islands alone, millions of gallons of wine are produced, and the area in vineyards can be greatly extended. The grape crop is never injured by frosts, and conditions in regard to moisture are more favourable to avoidance of loss through mildew than in the Ohio Valley, which formerly was the chief centre on this continent of the production of Catawba wine.

To find European parallels to the various climates of Ontario which have been described, would be no easy task. Individual districts will find winter parallels in the Crimea, on the banks of the Danube, and at Berlin on the one hand, and on the other at St. Petersburg, Moscow, Astrachan and in Central Russia. The summers of parts of the Province are paralleled in those of Lisbon, Northern Spain and Italy, Southern France, the lower Danube and Constantinople, or in the cool summers of Paris and Berlin. The Ottawa Valley and the central and inland parts of the Province of Ontario have summers like those of Vienna. Toronto at any season of the year differs but little in temperature from Bucharest. The month of July at Hamilton and Windsor is almost as warm as at Oran, in Algiers, and but

little cooler than at Jerusalem, in Syria. In general, it may be said that a line from the Danube through Bucharest to Moscow would furnish parallels to the climates along a line from Windsor north-easterly to Pembroke, on the Ottawa—though the summers of the latter place are warmer than those of Moscow.

By a British standard the summers of much of the Province may be considered long. May in south-western Ontario is warmer than July at Edinburgh. September is warmer than July at London, and warmer than September at Vienna. The vine, maize and sorghum fully mature in most parts of the Province south of the 46th parallel, and in not a few districts yield as abundantly as in any part of America or Europe. The limitations on the cultivation of the vegetables of similar latitudes in Europe is more in the intensity of the winter frosts than in the lack of a sufficiently long or warm summer.

NOTE.

The length and heat of Ontario summers contrasted with those of other places in Canada, and various places in Europe, may be seen by a glance over the following table. The means for Toronto, Hamilton, Windsor and Winnipeg are derived from the annual records of the Canadian Meteorological Service for eight years (1874-81); those for Montreal from same records for six years (1875-80); those for Pelee, from C. M. S. station reports for three and a half years. The averages for European Stations are quoted from Blodgett's "American Climatology," and are for periods, with few exceptions, longer than eight years.

MONTHLY MEANS OF CANADIAN SUMMERS.

	MAY.	JUNE.	JULY.	AUG.	SEPT.
Toronto.....	54.2	62.6	69.0	67.8	60.3
Hamilton	57.6	66.0	73.4	71.3	63.9
Windsor	60.8	67.0	73.4	71.4	63.8
Pelee	59.2	67.1	73.5	72.9	66.3
Montreal, Que.	55.0	65.0	69.8	68.1	59.0
Winnipeg, Man.	52.9	61.8	67.3	64.1	51.9

MONTHLY MEANS OF EUROPEAN SUMMERS.

Edinburgh	50.3	56.0	58.7	56.8	53.4
Aberdeen	52.3	56.7	58.8	58.0	54.6
York	54.5	59.2	62.0	61.1	55.7
London	55.8	58.7	61.7	58.9	56.6
Dublin	54.4	60.2	61.5	61.4	56.5
Paris	58.1	62.7	65.6	65.3	60.1
Rochelle	59.4	67.5	69.0	66.5	62.4
Vevay	58.2	64.4	68.4	64.4	59.6
Munich	57.6	62.1	64.7	64.1	58.1
Berlin	56.5	63.3	65.8	64.4	58.4
Königsberg	52.0	57.4	62.6	61.7	53.6
Vienna	62.1	67.5	70.7	70.0	61.9
Bucharest	56.3	62.5	68.1	65.2	58.3